09-05-00

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August 31, 2000
Agent's Docket No. **UPA-00178**

Assistant Commissioner for Patents
Washington, D.C. 20231

Re: **U.S. Utility Patent Application**
Inventor: **Fen-Ren Chien, Lung-Chien Chen, and Yi-Tsung Chang**
Title: **The Manufacturing Method Of A Callium Nitride-Based Blue Light Emitting Diode (LED) OHMIC Electrodes**

Sir:

The above-identified utility patent application is transmitted herewith for filing:

Enclosed are:

1. **Eleven (11)** sheets of specification, claims, and abstract.
2. **Five (5)** sheets of drawings containing FIGs. **1** through **6**.
3. An executed Declaration and Power of Attorney for Utility Patent Application.
4. An executed Verified Statement Claiming Small Entity Status Under *37 CFR 1.9(F)* and *1.27(B)* by **Fen-Ren Chien, Lung-Chien Chen, and Yi-Tsung Chang**.
5. An executed Verified Statement Claiming Small Entity Status Under *37 CFR 1.9(F)* and *1.27(C)* by **Formosa Epitaxy Incorporation**.
6. An Information Disclosure Statement including Form PTO-1449 (List Of Prior Art Cited By Applicant) and a copy of US Patent No. 5,563,422.

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as Express Mail in an envelope addressed to: Box New Application, Assistant Commissioner for Patents, Washington, D.C. 20231, on the date shown below.

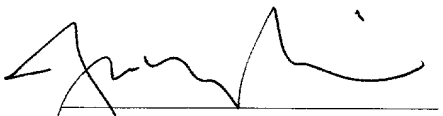
Date. Aug. 31, 2000 Mail Label EK446903714US

By _____
Jason Z. Lin

7. A Credit Card Payment Form (PTO-2038) for the payment of **$345.00** to cover the **Basic Utility Patent Filing Fee** (**two** independent claims and **thirteen** dependent claims).
8. A Recordation Form Cover Sheet and an Assignment which the Commissioner is requested to record and return to the undersigned.
9. A Credit Card Payment Form (PTO-2038) for the payment of **$40.00** to cover the **Assignment Recordation Fee**.

Please kindly acknowledge receipt of the above items by having your mailroom stamp and return the enclosed postcard.

Respectfully submitted,



Jason Z. Lin
Agent for Applicant
Reg. No. 37,492

Applicant or Patentee: Fen-Ren CHIEN, Lung-Chien CHEN & Yi-Tsung CHANG

Docket No. UPA-00178

Serial or Patent Number: _____

Examiner: _____

Filed or Issued: _____

Art Unit: _____

Title: THE MANUFACTURING METHOD OF A GALLIUM NITRIDE-BASED BLUE LIGHT EMITTING DIODE (LED) OHMIC ELECTRODES

VERIFIED STATEMENT (DECLARATION) BY AN INDEPENDENT INVENTOR CLAIMING SMALL ENTITY STATUS UNDER 37 CFR 1.9(F) AND 1.27(B)

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in *37 CFR 1.9(c)* for the purpose of paying reduced fees under *Section 41(a) and (b)* of *Title 35, United States Code*, to the Patent and Trademark Office with regard to the invention entitled THE MANUFACTURING METHOD OF A GALLIUM NITRIDE-BASED BLUE LIGHT EMITTING DIODE (LED) OHMIC ELECTRODES

by Fen-Ren CHIEN, Lung-Chien CHEN & Yi-Tsung CHANG

described in :

- [X] The specification filed herewith.
- [ ] Patent application serial number _____, filed _____.
- [ ] PCT international patent application no. _____, filed _____.
- [ ] Patent number _____, issued _____.

I have not assigned, granted, conveyed, or licensed and am under no obligation under contract or law to assign, grant, convey, or license any rights in the invention to any person who could not be classified as an independent inventor under *37 CFR 1.9(c)* if that person had made the invention, or to any concern which would not qualify as a small business concern under *37 CFR 1.9 (d)* or a nonprofit organization under *37 CFR 1.9(e)*.

Each person, concern or organization to which I have assigned, granted, conveyed or licensed or am under an obligation under contract or law to assign, grant, convey or license any rights in the invention is listed below:

- [ ] No such person, concern or organization.
- [X] Persons, concerns or organization listed below.

Full Name: Formosa Epitaxy Incorporation

Address: NO. 99,LUN YUAN 1ST ROAD,LUNG-TAN, TAOYUAN,TAIWAN,R.O.C.

[ ] Individual [X] Small Business Concern [ ] Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate *(37 CFR 1.28 (b))*.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both , under *Section 1001* of *Title 18* of the *United States Code*, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Fen-Ren CHIEN	Lung-Chien CHEN	Yi-Tsung CHANG
Name of Inventor	Name of Inventor	Name of Inventor
Signature of Inventor	Signature of Inventor	Signature of Inventor
August 21, 2000	August 21, 2000	August 21, 2000
Date	Date	Date

[ ] CONTINUED ON PAGE 2

Fen-Ren CHIEN, Lung-Chien CHEN
& Yi-Tsung CHANG

Applicant or Patentee: _____ **Docket No.** UPA-00178

Serial or Patent Number: _____ **Examiner:** _____

Filed or Issued: _____ **Art Unit:** _____

Title: THE MANUFACTURING METHOD OF A GALLIUM NITRIDE-BASED BLUE LIGHT EMITTING DIODE (LED) OHMIC ELECTRODES

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS

37 CFR 1.9(F) AND 1.27(C) - SMALL BUSINESS CONCERN

I hereby declare that with regard to the small business concern identified below I am

☒ the owner of the small business concern

☐ an official of the small business concern empowered to act on behalf of same

NAME OF CONCER. Formosa Epitaxy Incorporation

ADDRESS OF CONCERN NO. 99, LUN YUAN 1ST ROAD, LUNG-TAN, TAOYUAN, TAIWAN, R. O. C.

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 37 CFR 1.9(d), for purpose of paying reduced fees under section 41 (a) and (b) of title 35, United States Code in that the number of employees of the concern, including those of its affiliates, does not exceed five Hundred(500) persons. For purposes of this statement (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns the affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention entitled: THE MANUFACTURING METHOD OF A GALLIUM NITRIDE-BASED BLUE LIGHT EMITTING DIODE (LED) OHMIC ELECTRODES

by inventor(s) Fen-Ren CHIEN, Lung-Chien CHEN & Yi-Tsung CHANG described in

☒ The specification filed herewith

☐ Patent application serial number _____ , filed _____

☐ PCT international patent application no. _____ , filed _____.

☐ Patent number _____ , issued _____

If the right held by the above identified small business concern are not exclusive, each individual, concern or organization having the rights to the invention is listed below and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9 (c) or by any concern which would not qualify as a small business concern under 37 CFR 1.9 (d) or a non-profit organization under 37 CFR 1.9 (e)

Full Name Formosa Epitaxy Incorporation

Address NO. 99,LUN YUAN 1ST ROAD,LUNG-TAN, TAOYUAN, TAIWAN, R.O.C.

☐ Individual ☒ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate *(37 CFR 1 29(b))*.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both , under *Section 1001* of *Title 18* of the *United States Code*, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed

NAME OF PERSON SIGNING Jung-Chi CHIEN

ADDRESS OF PERSON SIGNING NO. 99, LUN YUAN 1ST ROAD, LUNG-TAN, TAOYUAN, TAIWAN, R. O. C.

SIGNATURE. Jung-Chi Chien DATE August 21, 2000

THE MANUFACTURING METHOD OF A GALLIUM NITRIDE-BASED BLUE LIGHT EMITTING DIODE (LED) OHMIC ELECTRODES

FIELD OF THE INVENTION

This invention is related to a manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) ohmic electrodes and a transparent conductive layer (TCL). More specifically, it's related to a ohmic electrode and a transparent conductive layer which forms a thin composite layer upon P type gallium nitride epitaxial layer.

BACKGROUND OF THE INVENTION

US Pat. No. 5,563,422 discloses a series of manufacturing method regarding gallium nitride(GaN)-based III-V compound semiconductor devices and techniques of ohmic electrodes. Figure 1 shows the dissection of said patented invention, which is about making a gallium nitride(GaN)-based III-V compound semiconductor light emitting diode 110 with P type electrode 115 and N type electrode 114. It contains: a substrate 111; a semiconductor stacking structure above that substrate with a N type gallium nitride(N-GaN)112-based III-V compound semiconductor and a P type gallium nitride(P-GaN)113-based III-V compound semiconductor; a N type electrode(first electrode) 114 making said N type semiconductor layer in contact; a P type electrode(second electrode) 115 making said N type semiconductor layer in contact; and a pad 116 above the second electrode 115.

The second electrode 115(P type electrode) contacts to P type semiconductor 113 by forming a metallic material layer such as gold/nickel (Au/Ni) and annealing the metallic material layers.

Among said gallium nitride (GaN)-based III-V compound semiconductor devices, the second electrode 115 includes Ti/Al or Au, the second electrode 115 contains one or more metallic alloy selected from the group of gold, nickel, aluminum, platinum, tin, indium, chromium and titanium, in which gold/nickel alloy has better effects.

Even the second electrode 115 is made of gold/nickel; its resistance between electrodes is 1 k Ω , therefore, this invention offers a manufacturing method of the ohmic electrodes and the transparent conductive layer to lower serial resistance between the electrode and the gallium nitride.

SUMMARY OF THE INVENTION

The main purpose of this invention is to provide a manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) ohmic electrodes. Since the contacting resistance between the nickel chromium (NiCr) alloy and P type gallium nitride epitaxial layer is relatively low, a thin film alloy electrode can be grown upon the P-GaN epitaxial layer and N-GaN epitaxial layer. Moreover, better ohmic property is obtained by applying appropriate heat treatment to reduce the serial resistance between the electrodes and the P type and N type gallium nitride epitaxial layers and , in the same time, to lower the forward voltage of the light emitting diode.

Another purpose of the current invention is to offer a manufacturing method of a transparent conductive layer of a gallium nitride(GaN)-basedlight emitting diode made from NiCr alloy. By growing a layer of NiCr thin film upon P type gallium nitride epitaxial layer, and applying appropriate heat treatment on said alloy thin film to obtain better ohmic property and transparency. Since said alloy thin film is highly transparent in the wavelength range (400 - 700 nm) of visible light, its average transparency is 87.77%, which offers larger current-injecting area. The optimized transparency also improves its luminance.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is the dissection of the structure of the known gallium nitride (GaN) blue light emitting diode.

Figure 2 is the dissection of the structure of the gallium nitride-based blue light emitting diode ohmic electrode and transparent contacting electrical conducting layer, in according to present invention.

Figure 3 is the circular transmission line model of the structure of the invented gallium nitride-based blue light emitting diode ohmic electrode and transparent contacting electrical conducting layer, in according to present invention.

Figure 4 is the circular transmission line model of the structure of the invented gallium nitride-based blue light emitting diode ohmic electrode and transparent contacting electrical conducting layer, in according to present invention.

Figure 5 is the current-voltage characteristic curves of the invented

gallium nitride-based blue light emitting diode ohmic electrode and transparent contacting electrical conducting layer after 60 seconds heat treatment under different temperature conditions, in according to present invention.

Figure 6 is the transmission plot (with various visible light wavelengths) of the alloy thin film of the invented gallium nitride-based blue light emitting diode ohmic electrode and transparent contacting electrical conducting layer after 60 seconds heat treatment under different temperature conditions.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

All the growth of semiconductor layer is carried out with metalorganic chemical vapor deposition (MOCVD) techniques and the III-V alloy semiconductor of the gallium nitride-based are nitride semiconductor of III -valance element gallium.

As shown in figure 2, common techniques of the light emitting diode displays adopt surface emitting structure, they are sapphire (Al_2O_3) substrate layer 10, N type gallium nitride layer 11, N-electrode layer 12, active layer 13, P type gallium nitride layer 14, transparent electrode layer 15 and P-electrode layer 16.

This invention mainly is that there grows an alloy metallic thin film layer upon the P type gallium nitride layer 14 as shown in figure 2 to effectively disperse the injected current and take the advantage of its transparency to enhance the luminance. Examples are illustrated in the following,

EXAMPLE 1

For the sake of easier measurement of the contact resistance of P-electrode and surface resistance, the example of this invention is directly grow P type gallium nitride film layer upon sapphire C-face substrate using metalorganic chemical vapor deposition. (MOCVD)

As sown in Figure 2, a GaN epitaxial layer is grown upon the sapphire C-face substrate at about 1000 ℃. Since the magnesium (Mg) molecules haven't diffused into the crystalline lattice of the newly grown GaN crystal yet, Mg cannot be activated as an acceptor. The said gallium nitride eptixial layer is not a P type gallium nitride layer 14 but an epitaxial layer with high electrical resistance. Therefore, a process of rapid thermal annealing of 850 ℃ and 10 minutes needs to be applied to activate the epitaxial layer to be a P type gallium nitride layer 14.

Using Hall system, the sheet resistance of the P type gallium nitride layer 14 (R_s) is 1.9 x $10^4 \Omega/\square$, the mobility (μ) is 13.21 $cm^2/V\text{-}s$, concentration (p) is 1.26 x 10^{17} cm^{-3}.

In Figure 2, a circular transmission line model above the P type gallium nitride layer 14, as shown in Figure 4, is fabricated by photolithography, and then use Cr-Ni alloy (80% nickel and 20% chromium) as the material of vapor deposition. Under the pressure condition of 1.2 x 10^{-5} torr, vapor is being deposited upon P type gallium nitride layer 14 and results in a metallic thin film layer 15 as shown in Figure 3, said film thickness is controlled at around 100 angstrom. The circular transmission line model metal thin film, as shown in Figure 4, is

formed through the techniques of lifting-off.

Among the samples of the circular transmission line model as shown in Figure 4, the circular gap 22 has 9 different sizes, which are 3, 5, 7, 9, 15, 20, 25, 30 and 50 micrometer, respectively. The metallic thin film 21, 23 are the electrodes used to measure current-voltage characteristic curves. The conditions and results of the measurement are shown in Figure 5, which is also the current-voltage characteristic curve after 400~700 ℃ heat treatment for 60 seconds.

When measuring the current-voltage characteristic curve, the circular gap 22 is 50 micrometer, a better ohmic property can be obtained with above results, and circular transmission line model principle can be used to obtain contacting resistance (ρ_c) of 4.83×10^{-2} Ω-cm^2.

Finally, physical deposits a NiCr alloy thin film with thickness of 100 angstrom upon another P type gallium nitride which is against the metallic thin film layer 15 and P type gallium nitride layer 14, as shown in Figure 3; and then treats it with room temperature and 500~700 ℃ heat treatment for 60 seconds. Spectrophotometer measurements show the transparency of the metallic thin film at wavelength of 450 nm are 58.82%, 63.1%, 92.65%, as shown in Figure 6. Therefore, from the above example, the metallic thin film obtains better ohmic property and transparency after 700℃/60 seconds heat treatment.

Although the above example describes a transparent electrode manufacturing method of P type gallium nitride using sapphire as the substrate and physical deposits NiCr alloy thin film, said invention can be applied to the gallium nitride light emitting diode in the wavelength range

of the visible light.

The invention has been described herein with reference to certain preferred embodiments. However, as obvious variants thereon will become apparent to those skilled in the art, the invention is opt to be considered as limited thereto.

WHAT IS CLAIMED IS:

1. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) ohmic electrodes, comprising the steps of :

a. growing an alloy thin film upon a P type gallium nitride epitaxial layer ;

b. using lift-off techniques to obtain a circular transmission line model pattern made from the alloy thin film ;

c. heat treating the alloy thin film of the circular transmission line model pattern to obtain a better ohmic property ;

wherein the lower contacting electrical resistance between the NiCr alloy and the P type gallium nitride epitaxial layers decreases the serial electrical resistance between the P-GaN gallium nitride epitaxial layer and N-GaN gallium nitride epitaxial layer and lowers forward breakover voltage of the light emitting diode.

2. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) ohmic electrodes according to claim 1, wherein the vacuum pressure in growing said circular transmission line model alloy thin film is 1.2×10^{-5} torr.

3. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) ohmic electrodes according to claim 1, wherein the better temperature in heat treating said circular transmission lin model alloy thin film is 400~700 ℃.

4. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) ohmic electrodes according to claim 1, wherein the material of th said circular transmission line model alloy thin film is NiCr

alloy.

5. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) ohmic electrodes according to claim 1, wherein the composition of the nickel in the said NiCr alloy is 1% to 99%.

6. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer, comprising the steps of:

a. growing an alloy thin film upon the P type gallium nitride epitaxial layer ;

b. heat treating the thin film alloy, which makes the said alloy thin film be a transparent contacting electrical conducting layer and have a better ohmic property and transparency ;

wherein the better transparency and ohmic property of the said transparent conductive layer increases the area of the injected current, which makes the injected current effectively and uniformly disperses through the N-electrode.

7. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 6, wherein the said alloy thin film is grown by way of evaporation.

8. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 6, wherein the said alloy thin film is grown by way of sputtering.

9. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 6, wherein the said alloy thin film is grown by way of electron beam

evaporation.

10. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 6, wherein the material of the said contacting thin film is NiCr alloy.

11. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 6, wherein the better heat treatment temperature of the said alloy thin film is 400~700℃.

12. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 7, wherein the better heat treatment temperature of the said alloy thin film is 400~700℃.

13. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 8, wherein the better heat treatment temperature of the said alloy thin film is 400~700℃.

14. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 9, wherein the better heat treatment temperature of the said alloy thin film is 500~700℃.

15. A manufacturing method of a gallium nitride(GaN)-based blue light emitting diode (LED) transparent conductive layer according to claim 10, wherein the composition of the nickel in the said NiCr alloy is 1% to 99%.

ABSTRACT OF THE DISCLOSURE

A manufacturing method and its structure of a gallium nitride-based blue light emitting diode (LED) ohmic electrodes and a transparent conductive layer (TCL), which forms a thin composite layer upon P type gallium nitride and a composite thin film ohmic electrodes upon P type gallium nitride epitaxial layer and N type gallium nitride epitaxial layer, respectively. Heat treatment is applied to said composite thin film layer and composite thin film ohmic electrodes to obtain the optimized ohmic properties and transparency so as to uniformly disperse the injected current throughout the N type electrode.

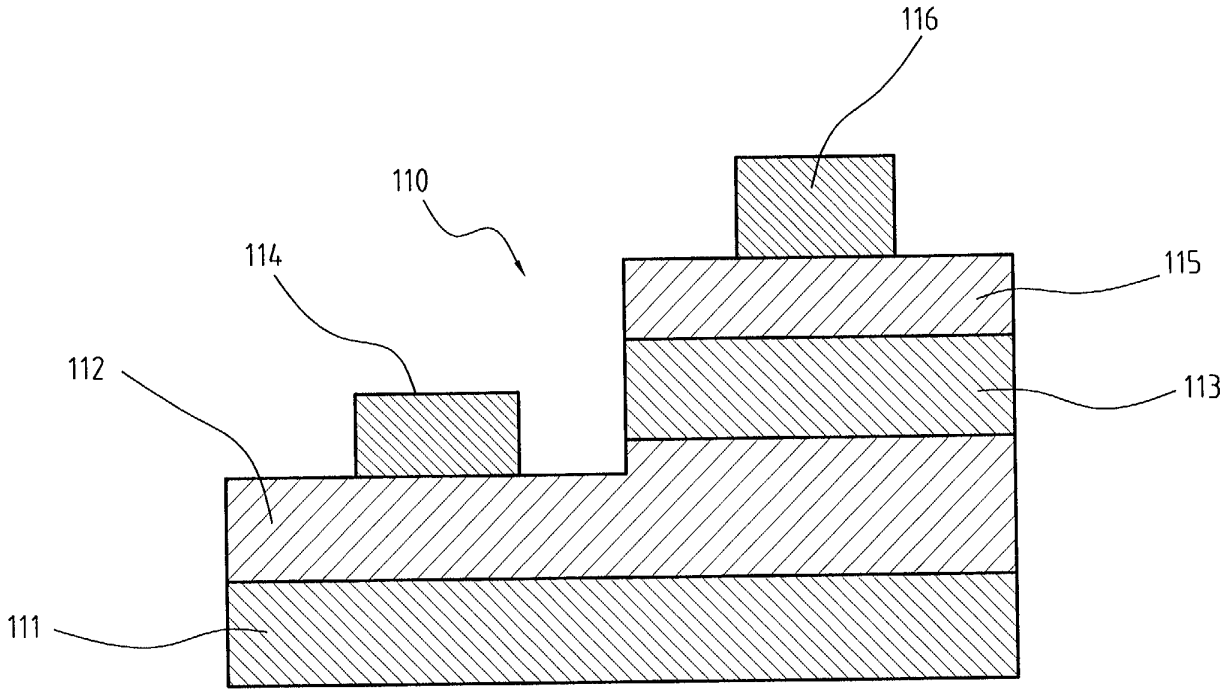


FIG. 1

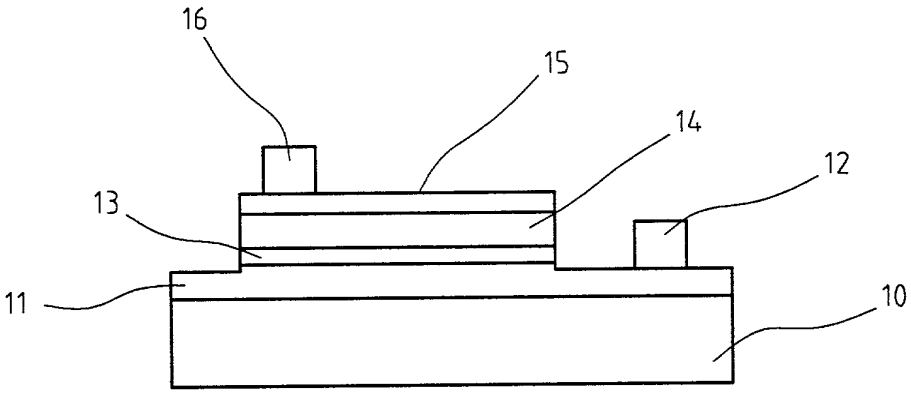


FIG. 2

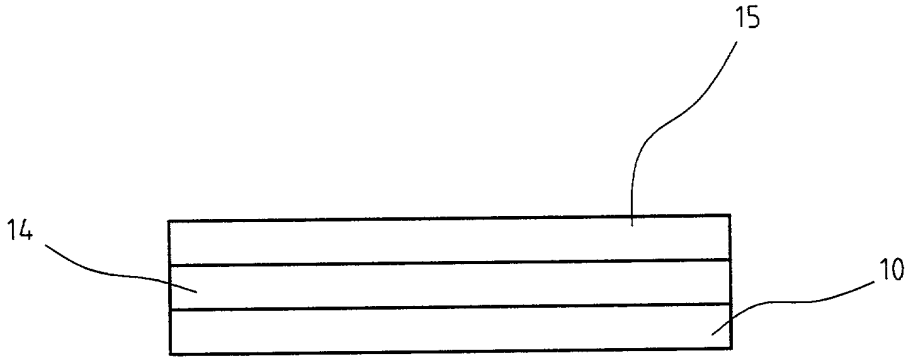


FIG. 3

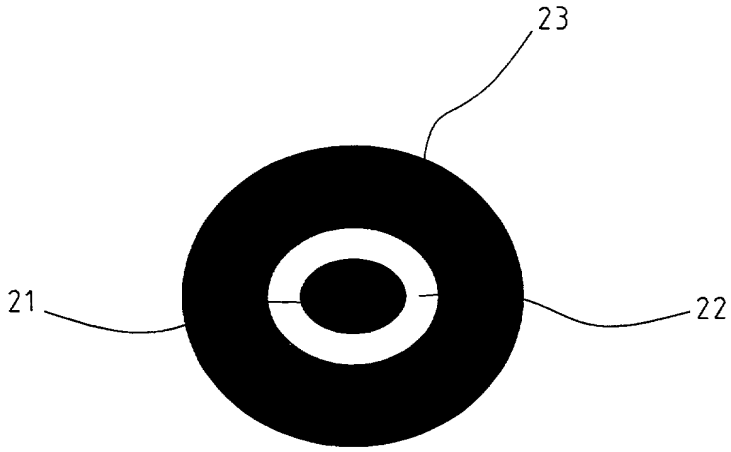
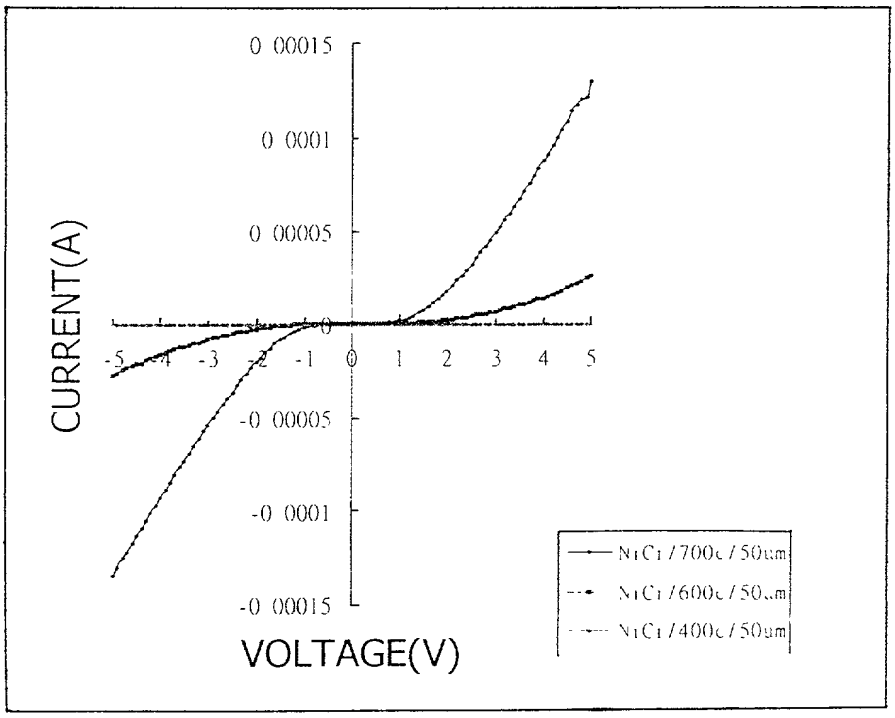


FIG. 4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VOLTAGE(V)
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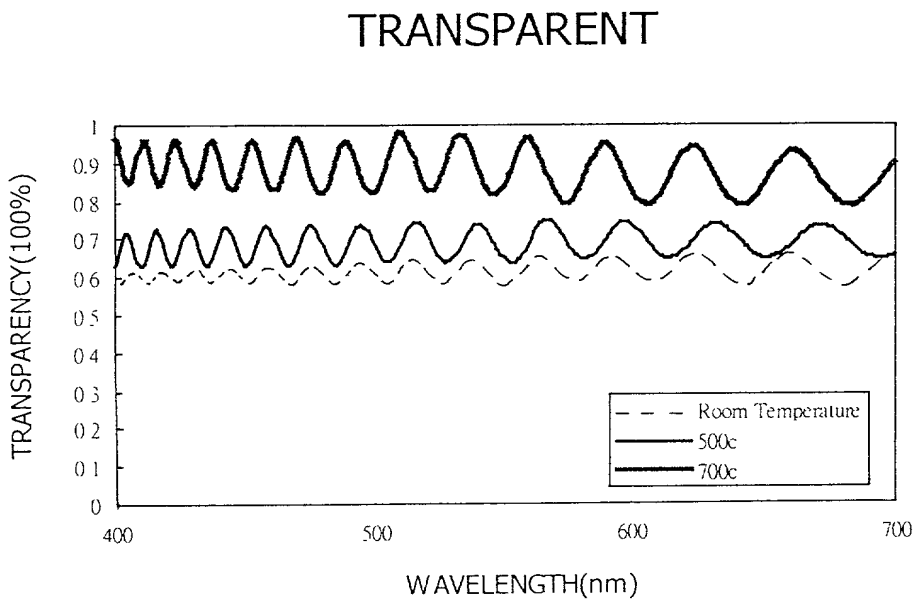
NiCl/600c/50um
NiCl/400c/50um

FIG. 5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TRANSPARENCY(100%)
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0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
400
500
600
700
WAVELENGTH(nm)
Room Temperature
500c
700c

FIG. 6

UNITED STATES OF AMERICA COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION	FILE NO. UPA-00178

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name and that I verily believe that I am the original, first and sole inventor(if only one name is listed below) or an original, first and joint inventor(if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

THE MANUFACTURING METHOD OF A GALLIUM NITRIDE-BASED BLUE LIGHT EMITTING DIODE (LED) OHMIC ELECTRODES

the specification of which is attached hereto, unless the following box is checked:

☐ was filed on _____ as United States patent application Serial Number _____, or PCT International patent application

No _____ and was amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, Section 1.56

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) or Provisional Application(s)

COUNTRY	APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	PRIORITY CLAIMED UNDER 35 U.S.C.119
			YES NO
			YES NO

I hereby claim the benefit under *Title 35, United States Code, Section 120* of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by *the first paragraph of Title 35, United States Code, Section 112*. I acknowledge the duty to disclose information which is material to patentability as defined in *Title 37, Code of Federal Regulations, Section 1.56* which became available between the filing date of the prior application and the national or PCT international filing date of this application.

UNITED STATES APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	STATUS (patented, pending, abandoned)

I hereby appoint the agent(s), whose name(s), Registration No(s). and address is list below/per attached, as my principal agent(s) with full power of substitution and revocation to prosecute this application, to transact all business in the Patent and Trademark Office connected therewith and to receive all correspondence.

SEND CORRESPONDENCE TO :

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I hereby declare that all statements made herein of my own knowledge are true and that all statement made on information and belief are believed to be true, and further that these statement were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under *Section 1001 of Title18 of the United States Code*, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF SOLE OR FIRST INVENTOR	INVENTORS SIGNATURE	DATE
Fen-Ren CHIEN	Fen-Ren Chien	August 21, 2000
RESIDENCE 4F, No. 36, Yu-Hsi Street, Yung-Ho City, Taipei Hsien, Taiwan, R. O. C.		COUNTRY OF CITIZENSHIP Taiwan, R. O. C.
POST OFFICE ADDRESS NO. 99, LUN YUAN 1ST ROAD, LUNG-TAN, TAOYUAN, TAIWAN, R. O. C.		
FULL NAME OF SECOND JOINT INVENTOR(if any)	INVENTORS SIGNATURE	DATE
Lung-Chien CHEN	Lung-Chien Chen	August 21, 2000
RESIDENCE 3F, No. 66, Lung-An Road, Hsin-Chuang City, Taipei Hsien, Taiwan, R. O. C.		COUNTRY OF CITIZENSHIP Taiwan, R. O. C.
POST OFFICE ADDRESS NO. 99, LUN YUAN 1ST ROAD, LUNG-TAN, TAOYUAN, TAIWAN, R. O. C.		
FULL NAME OF THIRD JOINT INVENTOR(if any)	INVENTORS SIGNATURE	DATE
Yi-Tsung CHANG	Yi-Tsung Chang	August 21, 2000
RESIDENCE No. 228-3, Chou-Mei Street, Pei-Tou Area, Taiwan, R. O. C.		COUNTRY OF CITIZENSHIP Taiwan, R. O. C.
POST OFFICE ADDRESS NO. 99, LUN YUAN 1ST ROAD, LUNG-TAN, TAOYUAN, TAIWAN, R. O. C.		

☐ CONTINUED ON PAGE 2